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Recognition of subspecies in *Asterolasia trymalioides* (Rutaceae: Rutoideae)

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Introduction

Asterolasia trymalioides F. Muell. was described in 1854 from material collected in the Cobberas Mountains in far eastern Victoria (Mueller 1854). Since then, the genus *Asterolasia* and *A. trymalioides* have been variously placed in *Eriostemon* Sm. (Mueller 1859) and *Pleurandropsis* Baill. (Anon. 1923).

Asterolasia trymalioides is a common component of some heathlands of treeless plains and peaks in the Australian Alps (McDougall & Walsh 2007) and has been the subject of ecological studies on shrub cycles and disturbance regimes (e.g. Williams & Ashton 1988). It is widely known as the Alpine Star-bush. However, the species has also been recorded well outside the Australian Alps Bioregion and in vegetation that is not alpine (Harden & Mole 2002). Wilson (2013) commented about a difference in leaf shape between Victorian and New South Wales (NSW) specimens but did not indicate whether these warranted taxonomic distinction, nor did he explore morphological differences between plants in the Australian Alps and those occurring elsewhere.

From our cursory examination of wild populations in the Australian Capital Territory (ACT), the Tinderry Range and Morton National Park in NSW, further taxonomic investigation was clearly warranted. Populations in the Tinderry Range and the ACT, at least, are visually distinctive

Abstract

Asterolosia trymalioides F.Muell. is revised. Analysis of morphological attributes supports the recognition of three taxa which are geographically separated. *Asterolosio trymolioides* subsp. *trymolioides* is a widespread shrub of alpine and subalpine heathlands in the Australian Alps; *A. trymolioides* subsp. *oreniticola* K.L.McDougall & C.J.Hook is confined to poorly-drained heaths of the Budawang Range of south-eastern New South Wales and *A. trymalioides* subsp. *villoso* K.L.McDougall & C.J.Hook is known from heathland of elevated rocky sites of the Australian Capital Territory and the Tinderry Range of south-eastern New South Wales, with an outlier in far eastern Victoria. A population in the Thredbo valley may be a hybrid of subsp. *trymolioides* and subsp. *villoso*.

Keywords: Rutaceae, *Asterolosio*, taxonomy, Budawangs, Namadgi

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with a dense indumentum on apical branchlets and leaves. Populations in Morton National Park are much taller than those we have seen elsewhere, occur in very different habitat and are geographically isolated. In this paper we evaluate differences between geographically isolated populations to assess whether the superficial differences we observed warrant taxonomic recognition.

Materials and Methods

All collections of *Asterolasia trymalioides* at MEL, CANB and NSW were examined. Places with few collections (the Tinderry Range near Michelago, Thredbo River in Kosciuszko National Park and Morton National Park in NSW, and Bowen Range in eastern Victoria) were searched and additional material obtained where possible. All but the Bowen Range population were relocated and new populations were located along the Thredbo River and in Morton National Park.

Measurements were made from dried material of the following characters where present.

1) *Hairs on stems and leaves.* The hairs of *A. trymalioides* are stellate and may be sessile or stalked. Stalked hairs, where present, are found amongst a dense indumentum of sessile hairs. The rays of the stellate hairs (collectively forming what are here termed the *stellae*) are typically shed with age, leaving upper leaf surfaces and old stems glabrescent, or at times somewhat hispid with the persistent stalks. Measurements were made on young stems where hairs were still plentiful. Measurements of maximum stalk length and stella width were made from three hairs on each collection and averaged.
2) *Leaf dimensions.* The leaves of *A. trymalioides* vary in size and shape on individual plants, usually depending on distance from the growing tip (i.e. maturity). Floral leaves are relatively small and overlapping. Measurements were made from isolated leaves on the primary stems of collections. Three measurements of petiole, leaf length (including petiole) and width, and the width of the leaf abaxial surface obscured ('obscuration') by the recurved margins were made for each collection and averaged. Leaf shape was characterised as the ratio of the leaf lamina to leaf width.
3) *Floral characters.* Three measurements were made on each flowering collection of petal length, staminal filament length, anther length, style length, and stigma width (when fully expanded) and averaged.

Very few collections contained fruiting material. Measurements of seeds and follicles were used in taxonomic descriptions but not morphometric analysis.

Data analysis

Of the collections examined, 48 were fertile and all characters could be included in analyses performed using Primer v.6 (Clarke & Gorley 2006). Three characters (stella width, leaf shape and petal width) were removed because they were highly correlated with related characters. The data were first normalised – the mean was subtracted from each value and divided by the standard deviation – to account for differences in the magnitude of measurements between variables and a matrix of similarities created using a Euclidean distance metric. Relationships between collections of *Asterolasia* were investigated using the routine CLUSTER (hierarchical agglomerative clustering). Structure in the dendrogram produced by CLUSTER was tested using the routine SIMPROF with a significance level of 5%. Infertile collections and those falling somewhat intermediately between groups in CLUSTER were assigned to groups where possible using CAP (canonical analysis of principal components) in Permanova+ (an add-in to Primer v6) on normalised leaf and indumentum characters only.

Results

Morphometric analysis

Three groups of collections were supported by the CLUSTER analysis (Fig. 1) - Group 1: ACT and Tinderrys, Group 2: Morton National Park and Thredbo and Group 3: the rest of the Australian Alps. Maximum hair stalk length and stella width, petiole length, leaf width, petal length and width, stigma width, anther and style length are likely to have diagnostic value because there is little or no overlap in these characters for two or all groups (Table 1). The CAP analysis allocated all of the infertile collections from the ACT (Mt Scabby, Mt Kelly, Sentry Box Hill and Mt Gudgenby) and the single collection from the Tinderry Range in NSW to Group 1. It also

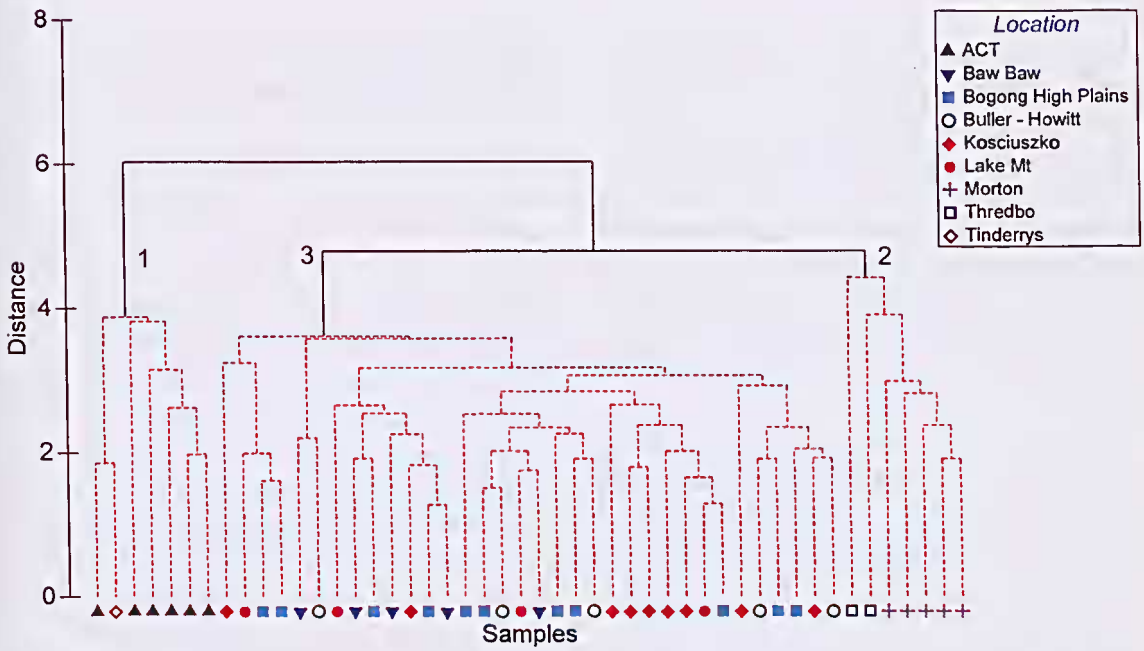

Figure 1. Dendrogram of fertile herbarium collections of *Asterolasia trymalioides* generated using the CLUSTER routine of Primer v.6. The solid lines indicate the groups supported at the 5% significance level using SIMPROF (in Primer v.6). The group numbers are those referred to in the text.

Table 1. Morphometric characters (mean ± SE) for the three groups identified in the CLUSTER analysis. A superscript number indicates that there was no overlap between the 5 and 95 percentiles of measurements for those groups (e.g. for anther length there was no overlap in measurements between Groups 1 and 2 but Group 3 collections overlapped with both Groups 1 and 2). Measurements for the two intermediate collections from Thredbo are shown – the number(s) in parentheses indicate the Group(s) within which the measurements fall.

Morphometric character	Group 1	Group 2	Group 3	Thredbo collections (groups)
Maximum stalk length (mm)	1.0 ± 0.1[2,3]	0.3 ± 0.0[1]	0.1 ± 0.0[1]	0.7–1.3 (1)
Maximum stella width (mm)	1.2 ± 0.1[2,3]	0.5 ± 0.0[1]	0.5 ± 0.0[1]	0.6–0.7 (2,3)
Leaf length (mm)	8.8 ± 0.4	7.2 ± 0.2	6.9 ± 0.2	6.2–6.3 (3)
Leaf width (mm)	4.3 ± 0.2[2]	3.6 ± 0.2	2.5 ± 0.1[1]	2.7–3.1 (3)
Leaf shape (lamina length:width)	1.4 ± 0.1	1.5 ± 0.0	2.2 ± 0.1	1.5–1.7 (1,2,3)
Obscuration (mm)	0.5 ± 0.1	0.4 ± 0.0	0.5 ± 0.0	0.5–0.8 (1,3)
Petiole length (mm)	2.7 ± 0.1[2,3]	1.6 ± 0.2[1]	1.5 ± 0.1[1]	1.5–1.7 (2,3)
Petal length (mm)	8.9 ± 0.5[3]	8.2 ± 0.3[3]	5.2 ± 0.1[1,2]	6.5–7.0 (1,2)
Petal width (mm)	4.4 ± 0.2[3]	4.4 ± 0.3[3]	2.5 ± 0.1[1,2]	2.6–3.5 (2,3)
Staminal filament length (mm)	4.8 ± 0.2	4.9 ± 0.4	4.5 ± 0.1	4.5–5.5 (1,2,3)
Anther length (mm)	1.6 ± 0.1[2]	1.2 ± 0.1[1]	1.4 ± 0.0	1.0–1.5 (1,2,3)
Stigma width (mm)	1.2 ± 0.1[3]	0.7 ± 0.0[3]	1.8 ± 0.1[1,2]	1.0–1.2 (1)
Style length (mm)	5.5 ± 0.5[3]	4.3 ± 0.2	2.5 ± 0.1[1]	3.7–6.0 (1,2,3)

allocated one of five collections from Thredbo and the single collection from Mt Bowen to Group 1. The remainder of the infertile collections were assigned to Groups 2 or 3 but since there is little diagnostic value in hair and leaf characters between Groups 2 and 3, the assignment of collections by CAP to these groups is not informative. The infertile ACT and Tinderry collections are consistent geographically with the identification of this group based on floral, hair and leaf characters. Mt Bowen, however, is in East Gippsland, 140 km from the nearest definite collection from Group 1 and Thredbo is situated between Mt Bowen and the ACT (Fig. 2).

There is strong support from the CLUSTER analysis for the taxonomic separation of plants of the southern ACT, Booroomba Rocks and Tinderrys (Group 1), Morton National Park (Group 2) and the remainder of the Australian Alps (Group 3). Based on infertile material, a disjunct collection from Mt Bowen in East Gippsland is likely to be part of Group 1. Plants from the Thredbo area are morphologically intermediate. Although the

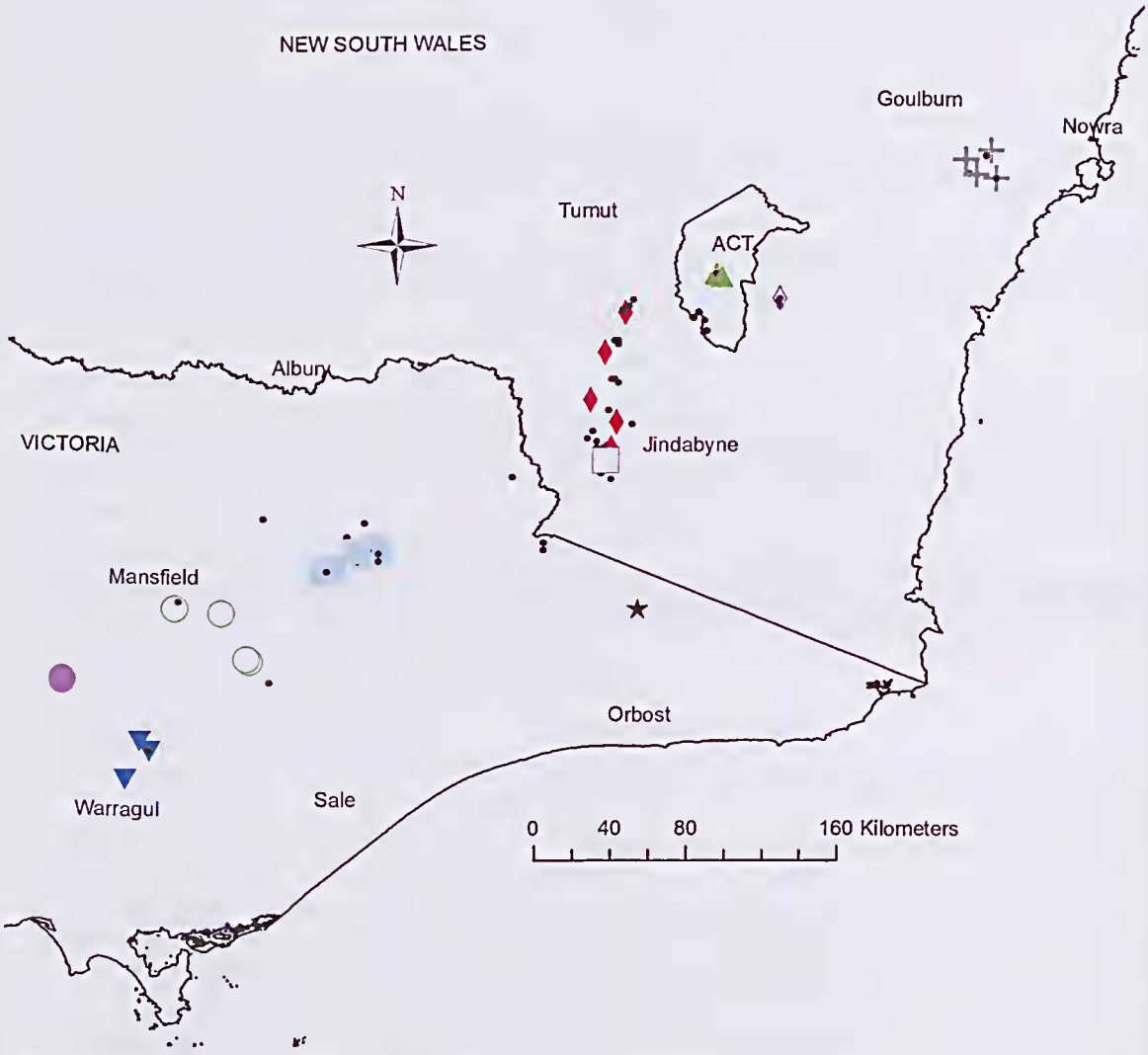

Figure 2. Distribution of collections from the nine broad locations delineated in Fig. 1. The symbols are the same as those used in Fig. 1 except for small dots, which are infertile collections not included in the CLUSTER analysis and the star, which is the Mt Bowen site assigned to Group 1 collections in the CAP analysis.

CLUSTER analysis placed them in Group 2 (Morton National Park), the CAP analysis placed most collections into the other groups. Given their proximity to Group 3 and their occurrence mid-way between Mt Bowen and the ACT, we suspect that they represent hybrids between Groups 1 and 3.

Discussion

We conclude that the current concept of *Asterolasia trymalioides* contains three taxa: one, which occurs in the Australian Alps from Lake Mountain and Baw Baw in Victoria to the Kiandra area of NSW (Group 3); one in Morton National Park, N5W (Group 2); and one in the mountains of the ACT and the Tinderry Range in N5W, with an outlier in the Bowen Range in eastern Victoria (Group 1). Group 3 contains the Type population in the Cobberas Mountains of north-eastern Victoria. We assign the names subsp. *villosa* to Group 1 plants and subsp. *areniticola* to Group 2 plants. We choose to designate these taxa as subspecies of *A. trymalioides*, given their similarity to other members of that species and substantial morphological differences from most other *Asterolasia* species (e.g. in pedicel length, flower colour, flower arrangement, leaf size, petiole length etc.). The Thredbo population (at an altitude of about 1150 m) is somewhat intermediate between all subspecies but most plants have the characteristic villous indumentum found in subsp. *villosa*. We suspect it is a hybrid between subsp. *villosa* and subsp. *trymalioides*, the nearest population of which is only 7 km away (although 500 m higher in altitude).

Taxonomy

Asterolasia trymalioides F.Muell., *Trans. Philos. Soc. Victoria* 1: 10 (1854)

Eriostemon trymalioides (F.Muell.) F.Muell., *Fragm.* 1(5): 106 (1859); *Pleurandropsis trymalioides* (F.Muell.) Anon., in Anon. (1923); Census Pl. Victoria, edn 1: 40.

Type citation: 'On the rocky summit of the Cobboras (sic) mountains in the Australian Alps, at an elevation of more than 6,000 feet above the level of the sea' (lectotype (here chosen): 'In [?]vertice montis Cobra locis graminosus lapidosus, ii.1854, *F. Mueller s.n.* MEL 708610!; possible isolectotypes: K 717302 (photo seen); MEL 106337!, 708609!; TCD 13339 (photo seen).

Nearly prostrate to erect *shrubs* to 2 m high; *branchlets* at least initially densely covered with pale to rusty stalked stellate hairs, older stems glabrescent. *Leaves* ovate to obovate or orbicular, petiolate, thick-textured, apex rounded or obtuse, margins revolute; upper surface initially stellate-pubescent, but finally glabrous, sometimes tuberculate; lower surface densely stellate-tomentose, with hairs like those of branchlets. *Flowers* terminal, solitary, closely subtended by several reduced floral leaves, sessile; *sepals* oblong, obovate or elliptic, minute, membranous, externally stellate-pilose; *petals* elliptic to obovate, yellow, stellate-tomentose outside; *stamens* 10, alternating long and short; ovary densely stellate-tomentose; *style* simple, occasionally with sparse stellate hairs, *stigma* ± hemispherical, 5-lobed, the lobes tuberculate and recurved. *Follicles* tomentose, ±cuneate, not beaked, c. 4 mm long. *Seed* ±reniform, c. 3 mm long, 1.5 mm wide, dark brown; aril elliptic, c. 2 mm long, 1.5 mm wide, membranous, closely adherent to the adaxial angle of the seed and soon deciduous.

Notes: Of the specimens of *A. trymalioides* from the Cobberas Mountain, the only one that includes the collecting date of February 1854 and the label (written by Mueller in Latin) that more or less matches the type citation had been annotated as the holotype (Paul G. Wilson *in sched.*). Four other sheets collected by Mueller from the Cobberas area were located in this study. Mueller is known only to have visited this area on two occasions (February and December 1854; Willis & Cohn 1993), so the undated specimens may or may not be part of the type collection. They are all in approximately the same stage of flowering/fruiting. To avoid any confusion, we have lectotypified the name on the dated Mueller specimen with the original handwritten label in Latin and treat the others as possible isolectotypes.

The synonym *Pleurandropsis trymalioides* was first published, as a *comb. nov.* in the 'Census of the plants of Victoria ...' (Anon. 1923). The authorship of this publication is obscure, being a census of names accepted by the 'Plants Names Committee' of the Field Naturalists Club of Victoria. In this publication, *Asterolasia* is maintained as a distinct genus, but containing only *A. muelleri* Benth., *nom. illeg.* (=*A. asteriscophora* (F.Muell.) Druce). Ewart (1930) maintained this distinction and nomenclature. Indeed, Ewart was likely to have been an influential member of the 'Plant Names Committee',

Key to subspecies

1 Leaves, stems and especially, new growth densely covered in stalked, stellate hairs with stalks up to 1.7 mm long and stellae up to 1.5 mm diam., the stalks persisting as sparse to moderately dense tubercles or short bristles; mountains of the ACT, the Tinderry Range in NSW, and Bowen Range in Victoria ..... 3. ***A. trymolioides*** subsp. ***villoso***

1: Leaves and stems variously hairy when young but stalks of stellate hairs, when retained, mostly < 0.5 mm long (very rarely to 0.9 mm) and stellae 0.3–0.9 mm diam., adaxial surface of leaves soon glabrous, but with scattered tubercles; Australian Alps in NSW and Victoria, and Morton National Park in NSW 2

2 Petals bright yellow and typically 7.5–10 mm long, leaf margins recurved but margins usually covering up to 10% of the abaxial surface; style mostly >3 mm long, stigma to 0.8 mm diam. when fully expanded; erect shrub to 2 m tall growing on sandstone in Morton National Park, NSW ..... 2. ***A. trymolioides*** subsp. ***areniticolo***

2: Petals dull yellow and typically 5–6 mm long, leaf margins recurved with margins covering c. 20% or more of the abaxial surface; style mostly <3 mm long, stigma > 1.3 mm diam.; prostrate or low shrub of the Australian Alps in Victoria and NSW ..... 1. ***A. trymolioides*** subsp. ***trymolioides***

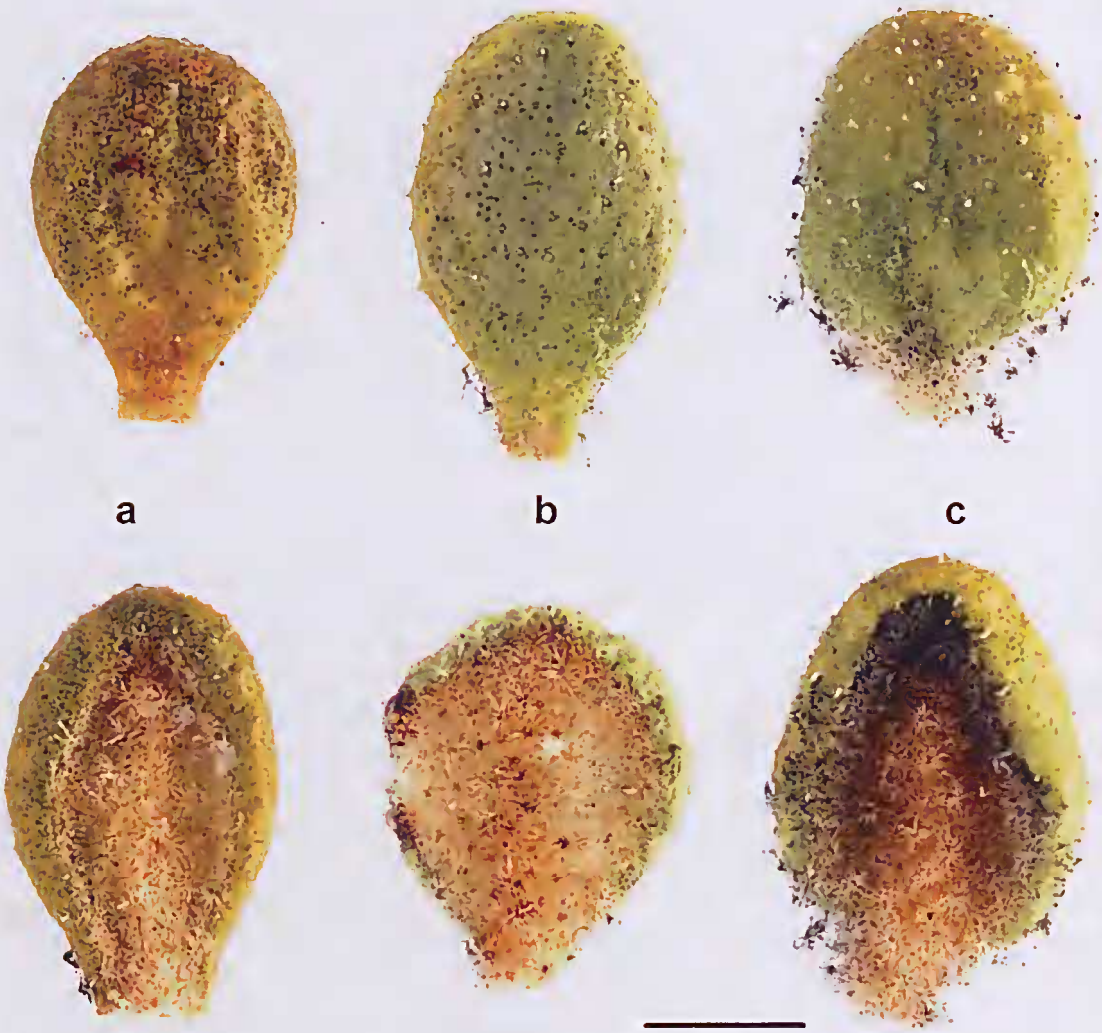

Figure 3. *Asterolasia trymalioides* leaves, upper and lower surfaces. **a.** subsp. *trymalioides*; **b.** subsp. *areniticola*; **c.** subsp. *villosa* (note the remnants of stalked hairs apparent near recurved margin of adaxial surface). Scale bar = 2 mm. (**a**: J.A.Jeanes 1930 (MEL); **b**: N.G.Walsh 8186 (MEL, holotype); **c**: N.G.Walsh 8102 (MEL)

being actively involved with club members in this period (Cohn 2005), but there is no attribution to him in the *Census*. Hence, authorship of *P. trymalioides* is correctly '(F.Muell.) Anon.' rather than '(F.Muell.) Ewart' as given in e.g. Wilson (2013).

Wilson (2013) described the sepals of *Asterolasia* as 'small, minute or absent' and those of *A. trymalioides* to be unusual in that they 'vary greatly in size on the same flower'. Of *A. phebalioides* F.Muell., the species he regarded as most closely related to *A. trymalioides*, he noted 'The 5 leafy to scarious bracts that subtend the flower occur in an inter-petaline position and may represent sepals'. After examining numerous flowers in the course of this study, both fresh and dried, it appears that the 'sepals' of *A. trymalioides* are similarly ambiguous; that is, the measured structures in the descriptions are as likely to be bracts as they are to be true sepals. Unlike most other members of the genus where the flowers are held clear of subtending leaves by distinct pedicels so that sepals, when present, are readily detected, these two species have essentially sessile flowers subtended by a series of decreasingly leaf-like bracts culminating in structures that resemble sepals. The varying lengths of these structures, even within individual flowers, suggests that they are not truly sepals, and like some other members of the genus, the flowers might be best described as lacking sepals.

Asterolasia phebalioides F.Muell., a rare shrub from Kangaroo Island and western Victoria, is perhaps closest in morphology to *A. trymalioides* but differs *inter alia* in having sessile, flat leaves and persistent adaxial leaf hairs.

1. *Asterolasia trymalioides* subsp. *trymalioides*

Low spreading shrub to 50 (rarely to 80) cm high, often ±prostrate; *hairs of leaves and branchlets* with stellae 0.3–0.6(–0.9) mm diam. and stalks to 0.3(–0.9) mm long; older stems often retaining remnants of hair-stalks. *Leaves* narrowly to broadly elliptic or obovate, (4.3–)5.6–8.1(–10.0) mm long (including petiole (0.4–)1.0–1.8(–2.7) mm), 1.7–2.9(–3.8) mm wide, apex rounded or obtuse, the recurved margins generally obscuring (11–)17–27 (–34)% of the lower surface; upper surface initially stellate-pubescent, but finally shiny and glabrous or

Figure 4. *Asterolasia trymalioides* subsp. *trymalioides*, flowering plant, Baw Baw plateau, Victoria (photograph I. Dunn, ©Royal Botanic Gardens Victoria)

sometimes weakly tuberculate. *Sepals* 1–2 mm long; *petals* (3.5–)4.9–5.8(–7.5) mm long, 2.0–3.0 mm wide, dull yellow; *staminal filaments* 3.1–5.2–(8.5) mm long; *anthers* 1–2 mm long; *style* 1.3–3.0(–4.5) mm long; *stigma* (1.3–)1.5–2(–2.8) mm diam. when fully expanded. Flowering: typically November–December but to late January in higher elevations in Victoria (Figs. 3, 4).

Selected specimens (of 58) examined: **NEW SOUTH WALES.** 1 km S of Daners Gap, Kosciusko area, 14.xii.1983, M. Gray 7057 & C. Totterdell (CANB); Burrumgubugee Hut, Kosciuszko National Park, 23.xi.2009, K.L. McDougall 1338 (CANB); 24 km NW of Jindabyne on the Geehi Reservoir road from Guthega power station, 20.iii.1984, R.G. Coveny 5400 (NSW); Happy Jack's Plains, Snowy Mtns, at creek crossing below hut, 19.xii.1967, E.M. Canning 443 & M.E. Phillips (CBG); Grey Mare Ridge, between Grey Hill and The Grey Mare, 27.xii.1968, A.N. Rodd 701 (NSW); western slopes of Mt Jagungal, Kosciuszko National Park, eastern side of Grey Mare Fire Trail, 9.xii.2009, K.L. McDougall 1347 (CANB); 7 km N of Kiandra along Snowy Mts. Hwy, 9.xii.1977, I.R. Telford 6909 (CBG). Victoria. Echo Flat, c. 2 km N of Lake Mountain summit, 21.xii.1983, S.J. Forbes 1911 (MEL, NSW); Baw Baw National Park. beside St Gwinear Link Trail about 500 metres from Loop Trail, 4.iii.2008, J.A. Jeanes 1930 (CANB, MEL, K, NSW); near summit of Mount Buller, E of Mansfield, 1.i.1996., A.R. Bean 9463 (BRI, MEL); on slopes around Mount Howitt, 6.i.1949, T.M. Whaite s.n. (NSW); The Gorge, Snowy Range - 3 km SW of airstrip, 26.xi.1980, N.G. Walsh 963 (MEL); Holmes Plain, southern Snowy Range, 19.xi. 1980; N.G. Walsh 978 (MEL); Buffalo Mountains, 1906, H.B. Williamson 1359 (MEL); Mt Hotham, 14.xii.1977, M. Gray 6843 (CANB); Mount Loch carpark area, near Mount Hotham, 2.xii.1986, P.G. Abell 235 & C. Herscovitch (NSW); near Cope Hut, Bogong High Plains, 21.xii.1970, L.A. Craven 1920 & K.L. Gunn (CANB, MEL); Bogong High Plains, 0.5 km NE of Mt Nelse South summit, 8.i.1993, N.G. Walsh 3484 (MEL); c. 900 m ESE of Mt McKay on a low rise, 17.xi.1997, M.F. Duretto 1258 (MEL); Mt. Bogong, on T-spur track, 29.xii.1964, M.U.M.C. s.n. (CBG); Mount Pinnibar, 24.ii.1973, A.C. Beauglehole 41581 (MEL).

Figure 5. *Asterolasia trymalioides* subsp. *areniticola*, flowering plant, type population, Morton National Park, New South Wales (photograph N. Walsh)

Distribution and habitat: The type subspecies occurs in alpine and subalpine vegetation from Lake Mountain in Victoria to Kiandra in New South Wales. It is very common on the Bogong High Plains in north-eastern Victoria, often in treeless grasslands and heathlands and extending into the alpine zone, but occasionally in open snow gum (*Eucalyptus pauciflora* subsp. *niphophila* (Maiden & Blakely) L.A.S.Johnson & Blaxell) woodland. In Kosciuszko National Park it does not occur in the alpine zone and is localised, having been recorded in open heathland in the Smiggins Hole area, Guthega, Burrumgubugee River valley, Happy Jacks Plain, Kiandra and footslopes of Mt Jagungal. Commonly associated species throughout its range include *Celmisia* spp., *Grevillea australis* R.Br., *Hovea montana* (Hook.f.) J.H.Ross, *Poa* spp., and *Kunzea muelleri* Benth.

Conservation status: Common across most of its range and (apart from ski resorts) occurs entirely within conservation reserves. Not currently rare or threatened but there are surprisingly few recent records from well-frequented places such as Mt Buffalo, and its distribution in NSW is very patchy. This subspecies is palatable to cattle (van Rees 1998) and is an obligate seeder – past land-use in the Australian Alps may have affected its current distribution. Applying IUCN (2012) criteria subsp. *trymalioides* could be considered 'near threatened' in that it currently does not qualify as endangered or vulnerable, but it is conceivable, through climate change or changes in management (e.g. recommencement of grazing), that it could qualify as threatened in the future.

Notes: Distinctive from the other subspecies in its low, spreading habit, leaves with broadly recurved margins, usually obscuring 20% or more of the abaxial leaf surface, in the relatively small flowers (petals generally <6 mm long, cf. >7.5 mm in other subspecies) and in the stigma lobes which are widely spreading (mostly >1.5 mm diam. c.f. <1.4 mm in other subspecies) at full expansion. On high, exposed mountains e.g. the summit area of Mt Nelse, Bogong High Plains, plants may be no more than c. 10 cm high and spread up to 50 cm diam. or more. In more sheltered sites, such as valleys of the Baw Baw plateau, shrubs may approach 1 m in height when occurring in taller heathlands. Victorian plants tend to have longer leaves than those in New South Wales (mean ± SE in Victoria = 5.8 ± 0.2 mm, in NSW = 4.5 ± 0.2 mm). Putative hybrids with subsp. *villosa* appear to occur in the Thredbo valley.

2. *Asterolasia trymalioides* subsp. *areniticola* K.L.McDougall and C.J.Hook, subsp. nov.

***Type*: NEW SOUTH WALES.** Morton National Park, c. 10 km NE of Nerriga, 400 m S of the Braidwood-Nowra Rd. Beneath electricity transmission lines, 6.x.2014, *N.G.Walsh* 8186 & *K.L.McDougall.* (holotype: MEL 2379919; isotypes: CANB, NSW).

Erect *shrub* to 1.5 (rarely to 2) m high; *hairs of leaves and branchlets* with stellae 0.6–0.8 mm diam. and stalks to 0.6 mm long; stems smooth and glabrous after c. 2 years of growth. *Leaves* ovate to obovate, sometimes suborbicular, 5.0–8.1 mm long (including petiole 0.8–2.1 mm), 2.1–4.3 mm wide, apex rounded, recurved margins obscuring up to 10% (rarely to 14%) of the lower surface; upper surface initially sparsely stellate-pubescent, but stellate hairs fallen by the time leaves are fully expanded, finally glabrous and ±shining, with scattered tubercles. *Sepals* 0.5–2 mm long; *petals* (6.0–)7.5–10.0 mm long, 3.5–5.1 mm wide, bright yellow; *staminal filaments* 4–6.3 mm long; *anthers* 1.0–1.5 mm long; *style* 3.0–4.8 mm long; *stigma* 0.6–0.8 mm diam. when fully expanded. Flowering: September–early December (Figs. 3, 5).

Specimens examined: **NEW SOUTH WALES.** Morton National Park; Main Road 4.5 km past Tolwong turn-off (at track to head of Ettrema Creek), 26.ix.2006, P. Carmen 304 & C. Hook (CANB, MEL); Pigeon House Range (near Nerriga), W of Jervis Bay, 14.ix.1954, E. Gauba s.n. (MEL); c. 4 km W of Tianjara Falls on the Nerriga-Nowra Road (close to the power lines), 11.x.1985, P. Ollerenshaw 1743 (CBG, NSW); 11.6 km along Touga Rd from Nerriga Rd, 2.x.2005, P. Carmen 271, P. Ollerenshaw & C. Hook (CANB, MEL, NSW); Touga Rd, 11.5 km north of Braidwood Rd, Morton National Park, 26.ix.2006, K.L. McDougall 1273 (CANB); Braidwood Rd, 4.5 km E of Touga Rd, Morton National Park, 26.ix.2006, K.L. McDougall 1274 (MEL); near Tullyangella Creek, tributary of Ettrema Creek, 28.i.1975, I. Olsen 2429 (NSW); 2 km S of Wilban Hill, Ettrema Plateau, W of Nowra, 15.iii.1969, B.G. Briggs 3005 (NSW).

Distribution and habitat: Apparently localised in the Budawang Range near Nerriga, south-eastern New South Wales (altitude 700–800 m), and perhaps endemic to Morton National Park. It is found in heathland typically growing in shallow soil over sandstone rock

slabs, occurring especially in areas of poor drainage. Associated species include *Acacia hamiltoniana* Maiden, *Allocasuarina distyla* (Vent.) L.A.S.Johnson, *Banksia spinulosa* Sm., *Dampiera stricta* (Sm.) R.Br., *Epacris microphylla* R.Br. var. *microphylla*, *Grevillea baueri* R.Br., *G. patulifolia* Gand. (Cav.) Druce, *Hakea teretifolia* (Salisb.) Britten, *Isopogon anemonifolius* (Salisb.) Knight, *Kunzea parvifolia* Schauer, *Lepyrodia anarthria* F.Muell., and *Pimelea linifolia* Sm.

Conservation status: Occasionally abundant and even co-dominant but apparently highly localised within Morton National Park. Estimated area of extent is approximately 30 ha, number of known populations is fewer than ten and total population estimated at c. 700 individuals. On these estimates, applying IUCN (2012) criteria it qualifies as vulnerable (VU). Observations and knowledge of biology of related species suggests that this is an obligate regenerator from seed. Populations are therefore vulnerable to fire intervals of shorter time than allows replenishment of the soil seed bank (approximately 3 years).

Notes: Differs from other subspecies of *A. trymalioides* in the adaxial surface of leaves being devoid of stellate hairs as soon as fully expanded, in the margins being only narrowly recurved (obscuring generally less than 10% of the leaf abaxial surface) and in the flowers with large (mostly 7.5–10 mm long), brightly coloured petals. It is apparently confined to poorly drained sandstone heaths of the Budawang Mountains.

3. *Asterolasia trymalioides* subsp. *villosa* K.L.McDougall and C.J.Hook, subsp. nov.

***Type*: AUSTRALIAN CAPITAL TERRITORY.** Namadgi National Park, Mt Scabby summit area, 9.xii.2013, *N.G.Walsh* 7992 (holotype: MEL 2378466; isotypes: CANB, K, NSW).

Erect to spreading shrub to 80 (rarely to 150) cm high;

Figure 6. *Asterolasia trymalioides* subsp. *villosa*, flowering plant, type population, Mt Scabby, Australian Capital Territory (photograph N. Walsh)

branchlets floccose, hairs with stellae (0.6)0.8–1.5 mm diam. and stalks (0.5–)1.0–1.3(–1.7) mm long above a dense indumentum of sessile stellate hairs; older stems glabrescent, but often retaining remnants of hair-stalks. *Leaves* ovate, or more commonly broadly ovate, broadly elliptic, orbicular or sometimes oblate, (4.2–)5.8–8.4(–10.5) mm long (including petiole 1.2–2.8(–4.0 mm)), 2.2–5.1 mm wide, apex rounded, revolute margins obscuring (2–)11–18(–31)% of the lower surface; upper surface initially stellate-pubescent, but finally tuberculate or sparsely hispid from the retained stubs of the stalked stellate hairs. *Sepals* 1–2 mm long; *petals* (6.5–)–8–10.7 mm long, 3.0–5.0 mm wide, bright yellow; *staminal filaments* 4.1–5.7 mm long; *anthers* 1.0–2.0 mm long; *style* (3.7–)4.7–6.0(–8.0) mm long (and often longer than stamens), *stigma* 0.9–1.2(–1.4) mm diam. when fully expanded. Flowering: October–December (Figs. 3, 6).

***Selected specimens (of 18) examined*: AUSTRALIAN CAPITAL TERRITORY.** 5ams Creek, c. 2 km S of Mt Kelly, 22.i.1992, A.M. Lyne 714, F.E. Davies, I.R. Telford & S. York (CANB, NSW); Scabby Range, Mount Scabby, 11.iii.1992, A.M. Lyne 727, P. Hewat & I.R. Telford (CANB, MEL, NSW, PERTH); Namadgi National Park, Mt Gudgenby, c. 400 m N of summit, 1.i.1995, N. Taws 444 (CBG); 5outhern 5ummit of Booroomba Rocks, W5W of Tharwa, 27.x.1970, R. Pullen 11038 (CANB); 3 km NW of Booroomba Rocks, 11.xii.1985, I.R. Telford 10127 & P. Beesley (CANB, MEL,NSW); Tennent District: c. 12 km E of Corin Dam, 13.xi.1982, L.G. Adams 3904 & J. Hook (CANB); Namadgi National Park. 5entry Box Mountain, c. 450 m 5W from summit, 12.xii.2013, N.G. Walsh 8102 (CANB, MEL, NSW); Namadgi National Park, Mt 5cabby summit area, 9.xii.2013.NEW 5OUTH WALES. Mt. Tinderry near Michelago, 7.x.1950, J. McNear s.n. (CANB); Tinderry Nature Reserve, Tinderry Twin Peak, c. 50 m W of summit, 19.v.1992, F.E. Davies 1728, S. Donaldson & S. Triffitt (CBG); Lower Little Thredbo River near Thredbo River, 2.xii.1981, J. Thompson 4153 (NSW); Little Thredbo River, 14.xi.2007, K.L. McDougall 1305 & L. Broome (MEL); Eastern side of Thredbo River, c. 500–750 m downstream of confluence with Little Thredbo River, 10.vi.2013, C. Cosgrove s.n., C. Hook & P. Carmen (MEL); Near junction of Thredbo and Little Thredbo Rivers, viii.1949, A.B. Costin s.n. (N5W 654466). **VICTORIA.** Bowen Range, N end, 4.iii.1971, A.C. Beauglehole 37197 (MEL).

Distribution and habitat: Occurs in shrublands, subalpine heaths and shrubby snow-gum woodlands of elevated rocky (usually granitic) sites of Namadgi National Park in the ACT, the Tinderry Mountains, with an outlying population in the Bowen Range (near Cabanandra) in eastern Victoria. Altitude range is 1100–1700 m. Commonly associated species include *Callistemon pallidus* (Bonpl.) DC., *Grevillea diminuta* L.A.S.Johnson, *Eucalyptus pauciflora* subsp. *debeuzevillei* (Maiden) L.A.S.Johnson & Blaxell, *Epacris robusta* Benth., *Kunzea muelleri* Benth., *Leptospermum namadgiensis* Lyne, *L. micromyrtus* Miq., *Oxylobium ellipticum* (Vent.) R.Br. The plants in the Thredbo valley, which are possible hybrids with subsp. *trymalioides*, grow in riparian open woodland with *Eucalyptus pauciflora* Sieber ex Spreng. subsp. *pauciflora* and *Leionema phylicifolium* (F.Muell.) Paul G. Wilson. The habitat of the only Victorian locality is unknown.

Conservation status: Scattered in suitable habitat in ACT and NSW, exceedingly rare in Victoria and not re-collected from the Bowen Range since 1971, despite several searches of the area. Estimated area of extent is approximately 80ha, number of known populations is around ten and the total population is estimated at c. 800 individuals. On these estimates, applying IUCN (2012) criteria it qualifies as vulnerable (VU). Observations and knowledge of biology of related species suggests that this is an obligate regenerator from seed. Populations are therefore vulnerable to fire intervals of shorter time than allows replenishment of the soil seed bank (approximately 3 years). In Victoria it may be extinct.

Notes: Differs from other subspecies of *A. trymalioides* in the adaxial surfaces of leaves retaining stellate hairs until after full expansion and the stellae being wider (mostly 0.8 mm diam. or more) and with longer (mostly >1 mm long) stalks, and in the flowers with large (mostly 7.5–10 mm long), brightly coloured petals.

Apart from several clustered populations in the mountains of Namadgi National Park of the ACT that border NSW, this subspecies is characterised by widely spaced and isolated populations (Fig. 2). The ACT populations are separated from the Tinderry population by 40 km, from the Thredbo valley (where putative hybrids with subsp. *trymalioides* occur) by about 80 km and from the Bowen Range by 140 km.

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Supplementary material. Morphometric data used in the analyses.

Accession	Primary collector	Max. stalk length (mm)	Max. stellae radius (mm)	Leaf length (mm)	Leaf width (mm)	Leaf shape (lamina length:width)	Obscur-ation (mm)	Petiole length (mm)	Petal length (mm)	Petal width (mm)	Staminal filament length (mm)	Anther length (mm)	Style length (mm)	Stigma width (mm)
CAN8207920	L. Craven	0.0	0.5	6.9	2.2	2.5	0.5	1.5	5.4	2.0	4.4	1.5	1.8	2.0
CANB252057	M. Gray	0.1	0.5	7.0	2.1	3.2	0.5	0.4	5.0	1.9	4.2	1.4	2.0	2.0
CANB335709	R. Pullen	1.1	1.1	8.3	4.6	1.3	0.2	2.2	8.0	3.8	4.2	1.5	5.1	1.4
CANB343351	N. Walsh	0.1	0.4	7.6	3.3	1.5	0.6	2.7	5.1	2.6	4.0	1.8	1.8	2.1
CANB779865	R. Purdie	1.0	1.5	8.2	4.7	1.2	0.8	2.5	7.0	4.5	4.1	1.4	4.1	0.9
CANB882927	K. McDougall	0.3	0.6	7.3	4.4	1.5	0.5	0.8	8.6	4.8	4.8	1.1	4.8	0.7
CANB882928	K. McDougall	0.1	0.6	6.7	3.6	1.4	0.3	1.6	9.1	5.3	6.3	1.1	4.1	0.8
CANB882931	K. McDougall	0.3	0.6	7.3	3.3	1.6	0.4	1.9	8.1	4.6	5.2	1.2	4.7	0.7
CANB882935	K. McDougall	0.9	1.3	10.5	4.9	1.6	0.8	2.7	10.1	4.9	5.1	1.8	4.8	1.3
CANB882936	K. McDougall	0.4	0.7	8.1	3.2	2.0	0.7	1.9	5.1	2.5	5.2	1.1	3.0	1.3
CAN8882937	K. McDougall	0.5	0.5	4.9	2.4	1.5	0.5	1.1	5.5	2.5	3.1	1.3	3.4	2.0
CANB882938	K. McDougall	0.4	0.9	7.2	3.2	1.6	0.5	1.9	5.3	2.2	3.5	1.1	3.2	1.6
CANB882939	K. McDougall	0.0	0.4	5.8	2.5	2.0	0.5	0.8	5.0	2.2	3.2	1.4	2.1	2.1
CANB882940	C. Hook	0.9	1.3	10.2	4.3	1.7	0.7	2.8	10.7	5.0	5.7	1.4	5.1	1.2
C8G15133	E. Carroll	0.0	0.4	6.3	2.5	1.8	0.5	1.7	4.0	2.5	4.5	1.3	1.4	2.5
C8G17937	E. Carroll	0.0	0.4	7.1	3.0	1.8	0.5	1.7	4.9	2.5	4.2	1.1	2.8	1.7
C8G7708532	I. Telford	0.1	0.4	5.8	2.6	1.7	0.5	1.4	4.8	2.5	4.2	1.0	2.1	1.7
C8G8311280	N. Walsh	0.0	0.6	5.7	2.3	2.0	0.3	1.2	4.7	2.6	4.0	1.4	1.7	1.8
C8G8505034	I. Telford	1.0	0.9	8.6	4.2	1.3	0.5	3.1	8.0	3.8	4.8	1.4	5.5	1.2
C8G8704215	I. Telford	0.0	0.3	7.7	2.2	2.9	0.3	1.2	5.8	2.8	5.0	1.3	2.5	2.0
CBG8764	M.U.M.C	0.0	0.4	8.2	1.9	3.2	0.5	2.2	5.1	2.8	4.6	1.3	2.4	1.9
CBG9209394	A. Lyne	1.3	1.1	7.3	3.9	1.2	0.6	2.6	8.5	3.9	4.4	1.6	6.0	1.2
MEL2014452	N. Walsh	0.1	0.6	5.7	1.9	2.6	0.3	0.8	5.1	2.5	4.5	1.8	1.3	1.9
MEL2049237	M. Duretto	0.0	0.3	8.2	2.3	2.8	0.7	1.7	6.0	3.0	6.5	1.7	3.0	1.9
MEL2097876	J. Luehmann	0.0	0.4	6.7	2.4	2.3	0.5	1.2	5.5	3.5	4.5	2.0	2.0	1.5

Accession	Primary collector	Max. stalk length (mm)	Max. stellae radius (mm)	Leaf length (mm)	Leaf width (mm)	Leaf shape (lamina length:width)	Obscur-ation (mm)	Petiole length (mm)	Petal length (mm)	Petal width (mm)	Staminal filament length (mm)	Anther length (mm)	Style length (mm)	Stigma width (mm)
MEL2369167	K. McDougall	1.3	0.6	6.3	3.1	1.5	0.5	1.5	7.0	2.6	5.5	1.0	3.7	1.2
MEL2369168	K. McDougall	0.2	0.6	5.6	3.1	1.2	0.6	1.7	5.6	3.1	5.1	1.1	4.0	2.0
MEL269867	A. Bean	0.1	0.7	8.1	2.8	2.3	0.5	1.4	5.4	2.0	4.7	1.2	1.3	1.9
MEL628627	N. Walsh	0.0	0.5	6.7	2.5	2.1	0.6	1.5	5.0	3.0	4.5	1.4	3.0	2.3
MEL641165	N. Walsh	0.0	0.5	6.0	2.1	2.3	0.6	1.2	5.1	2.0	3.9	1.5	1.5	1.5
MEL641253	N. Walsh	0.1	0.5	6.7	2.3	2.1	0.4	1.8	6.0	3.0	4.5	1.5	3.0	1.8
MEL665702	S. Forbes	0.0	0.4	6.8	2.3	2.1	0.5	1.8	5.0	3.0	6.0	1.5	3.5	1.9
MEL708607	F. Mueller	0.0	0.5	6.9	2.8	2.1	0.8	1.1	4.8	2.5	3.9	1.7	1.4	2.1
MEL708608	F. Mueller	0.2	0.7	7.8	2.6	2.2	0.6	2.0	4.6	2.8	4.0	1.5	2.7	1.7
MEL709151	E. Gauba	0.3	0.4	6.7	3.4	1.5	0.2	1.5	7.5	4.0	4.0	1.4	3.5	0.6
NSW208711	P. Abell	0.3	0.6	7.7	2.7	2.3	0.8	1.3	4.5	2.7	4.3	1.4	2.2	1.5
N5W262369	unknown	0.1	0.5	6.2	2.1	2.3	0.6	1.3	4.0	2.0	3.8	1.2	4.5	1.5
N5W262413	J. Thompson	0.7	0.7	6.2	2.7	1.7	0.8	1.7	6.5	3.5	4.5	1.5	6.0	1.0
NSW505045	E. Norris	0.1	0.5	8.0	2.3	2.8	0.4	1.7	5.5	3.0	4.0	1.5	3.0	2.8
N5W654460	A. Lyne	0.8	1.1	8.2	3.8	1.3	0.6	3.0	10.0	5.0	5.5	2.0	6.0	1.2
N5W654521	B. Briggs	0.3	0.3	7.8	3.5	1.7	0.4	2.0	7.5	3.5	4.0	1.0	4.5	0.8
N5W654525	J. Armstrong	0.0	0.4	8.3	2.6	2.9	0.8	0.9	5.5	2.6	5.5	1.6	1.6	1.6
N5W654526	B. Briggs	0.1	0.5	6.7	2.8	1.8	0.5	1.5	6.0	2.5	4.5	1.2	2.0	1.5
NSW654527	N. Ford	0.1	0.6	7.5	2.8	2.1	0.7	1.5	6.0	2.5	6.0	1.5	4.0	2.0
NSW654528	T. Whaite	0.1	0.5	7.5	2.5	2.0	0.3	2.5	5.0	2.5	4.5	1.8	3.0	1.8
NSW654530	F. Mueller	0.1	0.7	7.0	2.5	2.2	0.8	1.5	5.5	2.5	4.5	1.5	2.0	1.5
NSW70019	T. Stead	0.1	0.7	7.0	2.2	2.7	0.6	1.2	5.0	2.0	5.2	1.7	3.0	1.7
NSW70048	T. Stead	0.2	0.6	7.1	1.9	2.9	0.7	1.4	5.5	2.0	3.5	1.2	3.0	1.5